New Materials for Multifunctional Photonic ICs

D. Van Thourhout[1,3], Z. Wang[1,3], B. Tian[1,3`], Y. Shi[1,3], M. Pantouvaki[4], C. Merckling[4], Y. Hu[1,3], I. Asselberghs[4], S. Brems[4], L. Abdolahi[1,3], C. Alessandri[4], J.P. George[2,3], J. Beeckman[2,3], H. Min-Hsiang[4], P. Absil[4], J. Van Campenhout[4]

[1] Photonics Research Group, INTEC
[2] Department of Electronics and Information Systems
[3] Center for Nano- and BiophotonicsGhent University, Ghent, Belgium
[4] IMEC, Leuven, Belgium
dries.vanthourhout@ugent.be

Abstract
In this presentation we will report on our recent work on new materials that can be monolithically integrated on high-index contrast silicon or silicon nitride photonic ICs to enhance their functionality. This includes InP and InGaAs epitaxially grown on silicon for realizing efficient lasers [1-5], graphene and other 2D-materials for realizing compact electro-absorption modulators and non-linear devices [6-7] and ferroelectric materials for realizing phase modulators [8].

References
[1] M. Paladugu, C. Merckling, R. Loo, O. Richard, H. Bender, J. Dekoster, W. Vandervorst, M. Caymax, and M. Heyns, “Site selective integration of III-V materials on Si for nanoscale logic and photonic devices,” Cryst. Growth Des., vol. 12, no. 10, pp. 4696–4702, 2012.
[2] C. Merckling, N. Waldron, S. Jiang, W. Guo, N. Collaert, M. Caymax, E. Vancoille, K. Barla, A. Thean, M. Heyns, and W. Vandervorst, “Heteroepitaxy of InP on Si (001) by selective-area metal organic vapor-phase epitaxy in sub-50 nm width trenches□: The role of the nucleation layer and the recess engineering,” J. Appl. Phys., vol. 115, p. 023710, 2014.
[3] Z. Wang, B. Tian, M. Paladugu, M. Pantouvaki, N. Le Thomas, C. Merckling, W. Guo, J. Dekoster, J. Van Campenhout, P. Absil, and D. Van Thourhout, “Polytypic InP nanolaser monolithically integrated on (001) silicon.,” Nano Lett., vol. 13, no. 11, pp. 5063–9, Nov. 2013.
[4] B. Tian, Z. Wang, M. Pantouvaki, W. Guo, M. Clement, and J. Van Campenhout, “InP Nanowire lasers Epitaxially Grown on (001) Silicon ‘V-groove’ templates,” in IPRM 2014, paper Thu–B1–4.
[5] Z. Wang, B. Tian, M. Pantouvaki, W. Guo, P. Absil, J. Van Campenhout, C. Merckling, and D. Van Thourhout, “Room Temperature InP DFB Laser Array Directly Grown on (001) Silicon,” http://arxiv.org/abs/1501.03025, Jan. 2015.
[6] Y. Hu, M. Pantouvaki, J. Van Campenhout, S. Brems, I. Asselberghs, C. Huyghebaert, P. Absil, D. Van Thourhout, Broadband 10 Gb/s operation of graphene electro-absorption modulator on silicon, Laser & Photonics Reviews, 10(2), p.307-316 (2016).
[7] K. Alexander, Y. Hu, M. Pantouvaki, S. Brems, I. Asselberghs, S.-P. Gorza, C. Huyghebaert, J. Van Campenhout, B. Kuyken, D. Van Thourhout, “Electrically Controllable Saturable Absorption in Hybrid Graphene-Silicon Waveguides”, accepted for publication in Conference on Lasers and Electro-Optics (CLEO), United States, 2015
[8] J. George, J. Beeckman, W. Woestenborghs, P.F. Smet, W. Bogaerts, “Preferentially oriented BaTiO3 thin films deposited on silicon with thin intermediate buffer layers”, Nanoscale Research Letters, 8, p.1-7 (2013)